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A REVIEW OF "EXPERIMENTAL STUDIES OF THE DURATION OF LIFE" [1]

This series of eight papers[2], all from the Department of Biometry and Vital Statistics, Johns Hopkins University, represents, so far, the most valuable contribution to our quantitative knowledge of duration of life. The first five papers were prepared by Pearl and Parker, the sixth by Pearl, the seventh by Pearl, Parker, and Gonzalez, and the eighth by Gonzalez.

In their review of literature, the authors found that the bulk of quantitative data we have on duration of life is purely statistical and derived from indirect studies of the life of man. Man is very inconvenient material for a direct investigation of various phases of duration of life and the authors consider this the probable reason that these data have not contributed much in the way of general principles to biology.

The results of the work of these authors, who used different strains of Drosophila as material, show that in this insect and in man the laws of mortality are not different fundamentally. These results indicate another possible use of this fly in biological investigations, the character "duration of life" having been found to be one which is "genetically definite and workable." It should be noted in this connection and in comparison with life duration in man, that in the papers reviewed, duration of life in Drosophila is the duration of only the imaginal life. Many problems in human biology which can not possibly be investigated with man as material may in the future be studied in Drosophila. For example, it is not known what effect anesthetization has on the duration of life of a person, because anesthetization in man is usually performed only in connection with surgical operations and the expectation of life in a man surgically operated upon is most probably affected by the two factors, anesthetization and operation, which by the very nature of the case can not be studied separately. In nearly all genetic work with Drosophila, the flies are etherized and it was only one more step to determine the effect of this treatment on duration of life. It would appear that these flies may be etherized even four times in their life course without any significant effect on the life duration. Density of population affected duration of life inversely. Increased ventilation in the culture bottles allowed by a substitution as covering of these of one layer of No. 48 mesh bolting cloth for the usual cotton plug, was found to affect duration of life favorably. Adding

1 General contribution from the College of Agriculture No. 115.
2 Parts I to VIII, listed as bibliography.

to the food of the flies embryonic juice either from the chick or from the larvae of Drosophila itself, had no effect on life duration.

To those who may have to count large numbers of Drosophila flies, a description of a method of counting given and described by Pearl and Parker (6) should prove interesting. Briefly, the method consists in forcing the flies to go through a tube by the aid of a plunger and to come out one by one, and recording the number with the aid of a tally register as fast as they come out. The tube through which the flies have to pass empties into a container and connects by means of a funnel arrangement with the bottle which contains the flies to be counted.

Of greater interest to geneticists than these results are those which throw additional light on the correlation of increased vigor and increased heterozygozity; on the question of quantitative Mendelian inheritance; and the localization in the Drosophila chromosomes of factors controlling duration of life. In a cross between a long-lived stock (old Falmouth, wild type) and a short-lived stock (Quintuple), it was found that the F_1 flies were significantly less variable in duration of life than were either of the parent stocks. It is not known if this difference exists also in case of structural characteristics. It should be recalled that the opposite is true in the case of some quantitative characters studied in tobacco by other workers. The F_1 progeny were somewhat longer lived than either parent stock. The authors suspect that longer life in the F_1 was due to heterosis, in the same way that it is generally admitted that increased vigor in first generation corn crosses is the result of greater heterozygozity, as compared with the parents. In the same cross it was found that the character "duration of life" behaved in the F_1 and F_2 as a Mendelian character, with longer life as a simple dominant over shorter life and that "in the F_2 there was a definite and clear-cut segregation in respect of duration of life, long-lived and short-lived groups reappearing with virtually identical mean duration of life to those of the original parent stocks." Longer duration of life was invariably associated with normal wing and a shorter duration of life with vestigial wing. That longer life was not due to the mere presence of long wing was proved experimentally by clipping the wings of a number of flies at emergence from the puparia and observing the effect of absence of wing on duration of life. It was found that artificial absence of wing did not account wholly for the difference of duration of life between treated and untreated flies. What difference there was was believed to be due to the injurious effect of the operation. The association is believed to be neither a case of complete or perfect linkage between the gene for duration of life and that for vestigial nor one of association of a number of factors each of which mendelizes. It was assumed, rather, that "duration of life is not and of itself a separate and different character of the organism, but instead is simply the expression in time of the organization of the body, which organization may be regarded as a physicochemical, structural, physiological or functional, depending upon which of the aspects of organization we may at the time be emphasizing."

Gonzalez (8) made an attempt to determine if certain mutant genes of *Drosophila melanogaster* affect duration of life. These mutants are Black, Purple, Vestigial, Arc and Speck, all of which are in the second chromosome. All these mutants were found to affect duration of life in various degrees, Black having

the greatest effect of all. These same genes control certain morphological characters and affect sex without being linked with this.

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THE PROXIMATE COMPOSITION OF PALOMARIA SEED, OIL, AND RESIN [1]

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WITH TWO PLATES

INTRODUCTION

Palomaria oil, sometimes called *Bitaog* oil, is obtained from the nut of palomaria tree (*Calophyllum inophyllum L.*). It is greenish yellow. In India (1) it is called *dumba* oil, *dilo* oil, *laurel nut* oil, *poon seed* oil or *tamanu* oil. No palomaria oil has ever been exported from the Philippines, though some is extracted for local use. From India (1) it is exported to Burma and commands a price higher than coconut oil.

The palomaria plant is indigenous to Tropical Asia and Eastern Africa, and is found growing wild throughout the Philippine Islands along sandy beaches. No commercial plantations have as yet been established in the Philippines though the School of Forestry at Los Baños has successfully grown the trees on a plantation scale with promising results. According to Crevost (2), in India, the growth of the trees is very rapid, and they come to bearing in about two years. He further states that a yield of from 20 to 40 kilograms can be harvested from one tree, depending on its age.

In some parts of the Philippine Islands the palomarias are used as shade trees along streets, and several highways in Cochin China and Annam are said to be bordered with this tree (2).

Literature dealing with the chemical composition of the seed and oil of *Calophyllum inophyllum L.* is very meager. Lewkowitsch (3) states that the seed is composed of 62.9 per cent of shell and mesocarp and 37.1 per cent kernel. He further states that the kernels yield by expression in the hot, in a hydraulic press, 35.6 per cent of oil. Palomaria oil is reported by the same author to contain the glycerides of stearic, palmitic, and oleic acids. The exact proportions of each glyceride have never been reported.

Fendler (4) investigated the oil obtained from *Calophyllum* nuts from the island of Yap (Japanese Carolines) and he reports that the kernels yield 50.5 to 55.0 per cent of oil containing 15 per cent of greenish resin.

Crevost (2) states that Lefevre, by neutralizing the oil with caustic potash and separating the soaps thus produced from the remaining oil found that it contains 71.55 per cent of fatty oil and 28.45 per cent of resin. The resin obtained, he adds, is dark in color and melts at 30°C. to 35°C. The sample of resin obtained by the writer shows, however, that it is liquid at between 27°C. to 29°C.

The object of the present work was to ascertain the proximate compositions of the seed, oil, and resin and to study some of the properties of the oil and of the resin. The work was carried out in the Department of Agricultural Chemistry, University of the Philippines, at Los Baños, during the year 1922 to 1923.

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[1] Thesis for the degree of Master of Science in Agricultural Chemistry from the University of the Philippines, No. 180; Experiment Station contribution No. 228.

POSSIBLE USES OF PALOMARIA

THE SEED AND OIL

Samples of nuts from the provinces of Zambales, Ilocos Sur, Ilocos Norte, Cagayan, Rizal, and Laguna were cracked and the kernels separated from the shell. These different samples were found, on the average, to consist of 49.76 per cent shell and 50.24 per cent kernel. The kernels expressed by the hydraulic press in the hot yielded 62.30 per cent of an oily liquid. Therefore 31.62 per cent of oily liquid can be expressed from the seed. The total oil content of the kernel, as determined by ether extraction, was 72.25 per cent. The oily liquid expressed from the kernel consisted of 68.15 per cent yellowish oil and 31.85 per cent dark greenish resin or 21.23 per cent oil and 10.39 per cent of dark greenish resin calculated on the weight of the seeds. Fendler (4) reports that the percentage of resin may be as low as 15, but according to the experience of the writer the percentage varies with the method of extraction. Upon examination of the different methods of extracting the resin, Koss's (5) method appeared to be the most reliable, hence it was adopted in this investigation.

The crude oil is used for various purposes. In the provinces of Ilocos Sur, Ilocos Norte, Zambales, and Cagayan it is used for lighting purposes, for varnishing horns and similar materials and as a remedy for skin diseases. In many districts of India (1) the oil is used as a remedy for skin diseases, scabies, rheumatism and for the adulteration of chaulmoogra oil which is used in the treatment of skin ruptures.

Table I shows the proximate composition of the kernels of palomaria seeds.

TABLE I.—*Showing the analysis of palomaria seed kernel.*

Constituents.	Per cent.
Moisture	39.2
Ash	1.7
Ether extract (oil plus resin)	43.9
Protein (N×6.25)	2.9
Carbohydrates	5.9
Undetermined	6.4

The cake after expressing the oily liquid may have some value as a fertilizer although its ash constituents are rather low. It may not be good as an animal feed as it is bitter and may contain bitter principles. The oil finds application as raw material for the manufacture of varnishes, paints, and soaps.

Analyses of the ash from the kernel show that it is high in lime and ferric oxide and alumina, and fair amounts of sulfur trioxide and phosphoric acid anhydride. Table II shows the average composition of the ash.

TABLE II.—*Showing the analysis of the ash from the kernel.*

Constituents.	Per cent.
Insoluble matter and silica	5.9
Ferric oxide and alumina ($Fe_2O_3+Al_2O_3$)	34.9
Lime (CaO)	37.7
Phosphoric acid anhydride (P_2O_5)	7.2
Potash (K_2O)	2.2
Sulfur trioxide (SO_3)	6.3
Undetermined (by difference)	5.8

Some use has been found for the seed shells in Pangasinan Province, where they are utilized as containers for locally made sweets which are sold in the market under the name *calamay*.[2] The writer knows of no other use being made of the shells in the Philippines; they are generally allowed to go to waste.

[2] *Calamay* is composed principally of rice flour, sugar and coconut meat extract.

THE PREPARATION OF THE OIL SAMPLE FOR ANALYSIS

The oil can be obtained from the kernel in various ways: either by pressing or by extraction with some organic solvent. The hydraulic press is the most economical to use though not the most efficient. A disadvantage in the use of the press is that the product, because of its resin content, attacks the press plates and is colored thereby.

While extraction with some organic solvent is the most efficient the process is rather expensive, and with some of the solvents there is danger from fire during extraction and recovery of the solvent. Any ordinary organic solvent except alcohol can be used for extraction. Ether, carbon tetrachloride, and chloroform are excellent solvents for the oil.

THE NATIVE METHOD OF EXTRACTING THE OIL

In Zambales, Ilocos Sur, Ilocos Norte, and Cagayan provinces the oil is extracted from the kernels by the use of a native press. The nuts are first dried, then cracked and the kernels removed. The kernels are sliced and dried in the sun, the latter process taking from three to seven days depending upon the weather. The sun dried materials are ground fine by pounding them in a native mortar. The ground materials are put in bags made of gunny sacks or woven rattan and steamed until they become soft, then pressed while hot. The oil obtained in this way is crude, but is marketed or used without any further treatment.

The cake obtained from the first pressing still contains some oil. It is again dried in the sun, steamed and pressed, as before. The operation is repeated until practically all of the oil is pressed out.

So far, no use has been found for the cake obtained as a by-product in the manufacture of this oil, so it is allowed to go to waste.

PREPARATION OF SAMPLES FOR ANALYSIS

Most of the samples used in this work were obtained by extraction. Others were obtained by pressing.

Preparation of oil and resins.—The resins were removed from the oil by treating the crude liquid with 70 per cent alcohol. The resin is soluble in alcohol of this concentration while the oil is not. Solutions of certain salts of the alkali, such as sodium carbonate could be used in place of the alcohol but there is danger of partially saponifying the neutral oil.

The crude oil was thoroughly washed by passing it through a small orifice in a column of 70 per cent alcohol, contained in an old condenser tube. Complete separation of the resin could only be effected by several washings. The washing was continued till the oil would no longer impart color to the alcohol.

The resin-free oil was washed with warm water to remove all traces of alcohol. The operation was repeated until the washings were clear. Then the oil was mixed with anhydrous sodium sulfate in order to dehydrate it. The mixture was allowed to stand with occasional stirring, for about two days; it was then filtered.

The alcoholic extract was distilled to remove most of the alcohol. The concentrated alcoholic solution of resin was diluted to twice its volume with water, when the resin was thrown out of solution and a crude sample of resin was obtained. The crude resin was dissolved in cold dilute solution of sodium carbonate to saponify any trace of oil still contained in it. The solution was fil-

tered. The resin was then re-precipitated by acidifying the solution with dilute hydrochloric acid. The precipitated resin was taken up with ether and the latter removed by distillation at a temperature not higher than 65°C., and the last traces of ether removed in a vacuum desiccator over concentrated sulfuric acid.

THE COMPOSITION OF THE OIL

PHYSICAL AND CHEMICAL EXAMINATIONS

The crude oil is greenish yellow in thin layers and dark greenish when in layers of moderate thickness, while the refined oil is almost colorless with a slight yellow tinge in thin layers and yellow with a greenish tinge in thick layers. Some of the constants of the crude oily liquid, the resin-free oil, and the resin are given in Table III.

TABLE III.—*Showing the physical and chemical constants of oil with resin, oil without resin, and resin from palomaria seed.*

Constants.	Oil with resin.	Resin-free oil.	Resin.
Specific gravity	0.9435	0.9180	0.9940
Refractive index at 27.5°C.	1.4782	1.4638	1.5286
Iodine value	102.8	96.8	123.1
Saponification value	190.7	189.1	193.1
Acid value	75.4	14.8	204.3
Solidifying point (°C.)	—2.5° to —1°	—3° to —2°	—2° to —1°
Reichert-Meissl number	0.14	0.2	——
Acetyl value	——	36.1	——
Unsaponifiable matter	——	0.32	——

The low Reichert-Meissl number indicates the almost complete absence of glycerides of volatile acids. The acetyl value of the refined oil, 36.1, indicates the presence of hydroxilated acids. The acid value of the refined oil, 14.8, compared with 75.4 and 204.3 of the crude oil and resin respectively, indicates that the greater part of the acidity of the crude oil is due to the resin acids. The Reichert-Meissl number of the refined oil is higher than that of the crude oil. The saponification values of the crude oil, resin-free oil, and resin are fairly high. The iodine value of the refined oil indicates that it is a semi-drying oil. The amount of unsaponifiable matter is low, only 0.32 per cent.

A few physical and chemical constants of palomaria resin have been determined and Table IV shows that the saponification, resin, acid, and iodine values are high. Its high acid value explains why the crude oil containing resin attacks metallic containers.

TABLE IV.—*Showing the physical and chemical constants of palomaria resin.*

Constants.	Value.
Total saponification value	193.1
Resin value	155.2
Acid value	204.3
Iodine value	123.1
Per cent ash	0.08
Ester value	70.0
Specific gravity at 27.5°C.	0.9940
Gum value	37.9
Refractive index	1.5286

Solubility:—Very soluble in ether, chloroform, carbon tetrachloride, alcohol, acetone, acetic anhydride, and the salts of the alkali metals.

The resin is soluble in several organic solvents, practically in all those that have been tried. It is but slightly soluble, however, in alcohol at concentrations below 70 per cent.

SEPARATION OF THE SATURATED AND UNSATURATED ACIDS

The separation of the neutral oil into saturated and unsaturated acids was carried out by means of the lead-salt-ether method of Gusserow and Varrentrapp (6 and 7). Their method consists in the separation of the lead soaps of the acids, those of the unsaturated acids being much more soluble in ether than those of the saturated acids of high molecular weights. Various modifications have been offered by Oudemans (8), Kremel (9), Rose (10), and Mutter and de Koningh (11) and other investigators, but the main details of the method as originated by Gusserow (7) remain the same.

Renard (12), de Negri and Fabris (13) and other investigators used the method in the analysis of oils as far back as 1871, but since then no improvements have been made by which it would give more concordant results. Recently, Thomas and Yu (14) have introduced the magnesium-alcohol method but it has the disadvantage that it can not be used in the presence of fairly large amounts of oleic glycerides.

Lewkowitsch (6) states that the accuracy of the method depends principally on the quantity of ether used and on the temperature of observation. Baughman and Jamieson have apparently used this method in their investigations on hubbard squash seed oil (15), and also on okra seed (16), cantaloupe seed (17), cotton seed (18), soy bean (19), and sunflower-seed (20) oils, with a certain measure of success. They do not, however, give the details of their procedure.

In preparing the lead-salts of the saturated and unsaturated fatty acids and of separating the lead salts of the saturated fatty acids from those of the unsaturated, the methods given by Lewkowitsch (6), Villavecchia (21) and West and Montes (22) were followed.

The exact procedure adopted was as follows: The accurately weighed oil was saponified with approximately half normal alcoholic potash solution (100 cc. of the solution to 10 grams of oil) in the usual way. The alcohol used in the preparation of alcoholic potash and for the extraction of the resin and in washing was freed from aldehyde by the method of Dunlap (23).

The reaction product was carefully acidified with glacial acetic acid and then neutralized with alcoholic potash solution. The greater bulk of the alcohol was eliminated by distillation. While the neutralized solution was still warm, boiling 10 per cent lead acetate solution was added, gradually, with constant shaking, until a sudden coagulation of dirty white precipitate was noticed. Then 15 cc. more were added. The flask was filled with boiling water and then allowed to stand for at least 24 hours. The supernatant liquid was decanted through a dry filter paper, care being taken to leave most of the precipitate in the flask. The lead soaps were washed several times with hot water, allowing it to cool before decanting the supernatant liquid. The operation was repeated until the lead soaps were freed from the excess of lead.

Ether was added to the lead soaps at the rate of 200 cc. for every 10 grams of oil, and the mixture heated with frequent shaking under a reflux condenser for two hours. The mixture was then allowed to stand for twenty-four hours, when it was filtered, care being taken that most of the residue was left in the flask. The residue was then repeatedly washed with ether until a clear washing was obtained. The washings were added to the first filtrate.

The ethereal solutions contained the lead soaps of the unsaturated fatty acids while the residue consisted of the lead soaps of the crude saturated fatty acids. Several determinations were made on the separation of the saturated and unsaturated fatty acids in the same way. Table V gives a summary of the results obtained. The table shows that the refined oil contains on the average 70.8 per cent of unsaturated and 26.6 per cent of saturated fatty acids.

TABLE V-1.—*Showing the separation of the saturated and unsaturated fatty acids of palomaria oil by the lead-salt-ether method.*

EXPERIMENTS I AND II

	I.	II.
Weight of oil used	15.0792 gm.	18.5876 gm.
Weight of saturated acids (impure)	3.8725 gm.	5.1908 gm.
Weight of unsaturated acids and unsaponifiable matter	10.5726 gm.	13.1102 gm.
Impure saturated acids, determined	26.5%	28.7%
Unsaturated acids and unsaponifiable matter	69.3%	69.7%
Unsaponifiable matter	0.3%	0.3%
Iodine value of impure saturated acids	6.7	6.7
Iodine value of impure unsaturated acids	151.7	151.7
Unsaturated acids present in the saturated acids, calculated	1.1%	1.2%
Pure saturated acids corrected for unsaturated acids, calculated	25.4%	27.6%
Pure unsaturated acids corrected from unsaturated acids present in the saturated acids	70.4%	70.9%
Pure saturated acids, corrected	3.8325 gm.	5.1285 gm.
Pure unsaturated acids, corrected	10.6151 gm.	13.1725 gm.

TABLE V-2.—*Showing the separation of the saturated and unsaturated fatty acids of palomaria oil by the lead-salt-ether method.*

EXPERIMENTS III AND IV

	III.	IV.
Weight of oil used	49.5740 gm.	20.0634 gm.
Weight of impure saturated acids	12.8824 gm.	5.6013 gm.
Weight of unsaturated acids and unsaponifiable matter	35.2108 gm.	14.0706 gm.
Impure saturated acids, determined	26.8%	28.8%
Unsaturated acids and unsaponifiable matter, determined	70.2%	69.2%
Unsaponifiable matter	0.3%	0.3%
Iodine value of impure saturated acids determined	6.7	6.7
Iodine value of impure unsaturated acids determined	151.7	151.7
Unsaturated acids present in the saturated acids, calculated	1.1%	1.2%
Pure saturated acids corrected for the unsaturated acids present in the saturated acids	25.7%	27.6%
Pure unsaturated acids corrected for the unsaturated acids present in the impure saturated fraction	71.3%	70.4%
Pure saturated acids corrected	12.7407 gm.	5.5442 gm.
Pure unsaturated acids corrected	35.3525 gm.	14.1271 gm.

TABLE V.—*Showing the results of the separation of the solid acids from the liquid acids in palomaria oil by the lead-salt-ether method.*

Experiment.	Oil used.	Solid acids.		Liquid acids.	
		gram	*per cent*	*gram*	*per cent*
1	15.0792	3.8325	25.4	10.6151	70.4
2	18.5876	5.1285	27.6	13.1725	70.9
3	49.5740	12.7407	25.7	35.3525	71.3
4	20.0634	5.5442	27.6	14.1277	70.4
Mean			26.6		70.8

UNSATURATED ACIDS

The ethereal solution was transferred into a separatory funnel and the lead soaps of the unsaturated acids were decomposed with dilute hydrochloric acid (1:4) and the lead chloride formed was filtered off. The treatment with hydrochloric acid was repeated till no more lead chloride was formed. The ethereal solution was washed with cold water until the washing was no longer acidic. Then it was transferred to a 500 cc. Erlenmeyer flask and about 40 grams of anhydrous sodium sulfate added. The mixture was shaken and allowed to stand for at least 24 hours. The solution was filtered through a plaited filter paper into a tared flask. The sodium sulfate was washed completely with fresh ether. The ether was recovered and the residue weighed. The residue represented the greater part of the unsaturated fatty acids. The physical and chemical characteristics of the unsaturated acids are given in Table VI.

TABLE VI.—*Showing the physical and chemical constants of the liquid fatty acids from palomaria oil.*

Characteristics.	Value.
Solidifying point	—4° to —5°C.
Neutralization value	160.0
Mean molecular weight	277.7
Iodine number	151.7
Saponification value	286.3

The residue was brominated by the method of Eiber and Muggenthaler (6). The method is based on the different solubilities of the bromo-compounds in petroleum ether. The acids were dissolved in dry ether to a 10 per cent solution and cooled to −10°C. One cubic centimeter of bromine for every 2 grams of oil was then added gradually and in such a way that the addition of the required amount of bromine consumed 20 minutes, the mixture being shaken in the meanwhile. During bromination the temperature was naintained at $\pm$2°C.

After bromination the flask was set aside in a refrigerator and kept at the bromination temperature for three hours, at the expiration of which time the ethereal solution was decanted through a tared filter paper.

The ethereal solution contained no precipitate, showing the absence of linolenic acid, since hexabromo linolenic acid is insoluble in ether.

The liquor which contained an excess of bromine was washed repeatedly with 20 per cent sodium thiosulfate solution in a separatory funnel until all of the free bromine was completely removed. The bromine-free solution was dehydrated with anhydrous sodium sulfate.

The ethereal solution was distilled and the residue taken up with 400 cc. of petroleum ether (boiling point 25° to 40°C.) and then boiled under reflux condenser until all was dissolved. Then it was allowed to stand for 24 hours or until crystals of tetrabromolinolic acid had separated out. The crystals were filtered through a tared filter paper and the filtrate was concentrated to about half of its original volume. The precipitate was dried in an electric oven to a constant weight at a temperature of from 70° to 80°C.

After cooling and allowing the concentrated filtrate to stand for 48 hours a second crop was obtained. No further separation of crystals was obtained when for the third time the mother liquor was allowed to stand in a closet at a temperature of from 10°C. to 15°C. for at least three days. The crystals obtained were

treated in the same way as the first crop of the tetrabromo derivative. The solvent was then completely eliminated and the residue weighed. The residue represented a mixture of dibromo-oleic acid and tetrabromolinolic acid. From the weight of the residue and the bromine content of the same, the percentages of dibromo oleic acid and tetrabromolinolic acid were calculated. A summary of the results of a number of determinations is given in Table VII.

TABLE VII.—*Showing the results of the analyses of the liquid unsaturated acids from palomaria oil by the bromo-derivative method.*

Experiment.	Liquid acids used.	Total linolic tetrabromide found.	Linolic acid equivalent to tetrabromo-derivative found.		Total oleic dibromide found.	Oleic acid equivalent to dibromo-derivative found.	
	gram	*gram*	*gram*	*per cent*	*gram*	*gram*	*per cent*
1	60.0570	69.5103	32.4025	54.0	38.5492	24.5944	41.0
2	61.9570	69.5185	32.4559	52.4	40.8365	26.0377	42.0
3	60.7651	69.2641	32.3225	53.2	40.4260	25.7958	42.5
4	61.0526	69.7389	32.5471	53.3	40.0745	25.5715	41.9
Mean				53.2			41.9

TABLE VII-1.—*Showing the analysis of the liquid unsaturated fatty acids from palomaria oil by the bromo-derivative method.*

EXPERIMENT I

Sample of liquid acid used..... 60.0570 gm.
Hexabromide (ether insoluble bromide)..... None
First crop of tetrabromide..... 12.6562 gm.
Melting point 112°C. to 114°C.
Bromine content 53.4 per cent
Second crop of tetrabromide..... 2.6039 gm.
Melting point 112.5°C. to 113°C.
Bromine content 53.2 per cent
Residue (dibromide and tetrabromide)..... 92.7230 gm.
Bromine content 46.2 per cent
Dibromide in residue 38.5492 gm.
Tetrabromide in residue 54.1688 gm.
Total tetrabromide found..... 69.5103 gm.
Total dibromide found..... 38.5492 gm.
Oleic acid equivalent to dibromide found..... 24.5944 gm.
Linolic acid equivalent to tetrabromide found..... 32.4025 gm.
Percentages in the original samples:
Linolic acid..... 54.0
Oleic acid..... 41.0
Linolic glyceride..... 56.4
Oleic glyceride..... 42.8

TABLE VII-2.—*Showing the analysis of the liquid unsaturated fatty acids from palomaria oil by the bromo-derivative method.*

EXPERIMENT II.

Sample of liquid acid used..... 61.9570 gm.
Hexabromide (ether insoluble bromide)..... None
First crop of tetrabromide..... 14.0040 gm.
Melting point 112°C. to 115°C.
Bromine content 52.9 per cent
Second crop of tetrabromide..... 1.9020 gm.
Melting point 112°C. to 113.5°C.
Bromine content 53.2 per cent

Residue (dibromide and tetrabromide)..... 94.4490 gm.
Bromine content 45.9 per cent
Dibromide in residue 40.8365 gm.
Tetrabromide in residue 53.6125 gm.
Total tetrabromide found..... 69.5185 gm.
Total dibromide found..... 40.8365 gm.
Linolic acid equivalent to tetrabromide..... 32.4559 gm.
Oleic acid equivalent to dibromide found..... 26.0377 gm.
Percentages in the original sample:
Linolic acid..... 52.4
Oleic acid..... 42.0
Linolic glyceride..... 54.7
Olelic glyceride..... 43.9

TABLE VII-3.—*Showing the analysis of the liquid unsaturated fatty acids from palomaria oil by the bromo-derivative method.*

EXPERIMENT III.

Sample of liquid acid used,..... 60.7651 gm .
Hexabromide (ether insoluble bromide)..... None
First crop of tetrabromide..... 13.3610 gm.
Melting point 112.5°C. to 113°C.
Bromine content 53.2 per cent.
Second crop of tetrabromide..... 2.8350 gm.
Melting point 113°C. to 113.5°C.
Bromine content 53.5 per cent
Residue (dibromide and tetrabromide)..... 93.4941 gm.
Bromine content 45.9 per cent
Dibromine in residue 40.4260 gm.
Tetrabromide in residue 53.0681 gm.
Total tetrabromide found..... 69.2641 gm.
Total oleic dibromide found..... 40.4260 gm.
Linolic acid equivalent to tetrabromide..... 32.3255 gm.
Oleic acid equivalent to dibromide found..... 25.7958 gm.
Percentage in the original samples:
Linolic acid..... 53.2
Oleic acid..... 42.5
Linolic glyceride..... 55.6
Oleic glyceride..... 44.3

TABLE VII-4.—*Showing the analysis of the liquid unsaturated fatty acids from palomaria oil by the bromo-derivative method.*

EXPERIMENT IV.

Sample of liquid acid used..... 61.0526 gm.
Hexabromide (ether-insoluble bromide)..... None
First crop of tetrabromide found..... 13.2002 gm.
Melting point 112°C. to 114.5°C.
Bromine content 53.3 per cent
Second crop of tetrabromide found..... 2.6080 gm.
Melting point 113°C. to 114°C.
Bromine content 53.5 per cent
Residue (dibromide and tetrabromide)..... 94.0052 gm.
Bromine content 46.0 per cent
Dibromide in residue 40.0745 gm.
Tetrabromide in residue 53.9307 gm.
Total tetrabromide found..... 69.7389 gm.
Total oleic dibromide found..... 40.0745 gm.
Linolic acid equivalent to tetrabromide..... 32.5471 gm.

Oleic acid equivalent to dibromide found..... 25.5715 gm.
Percentages in the original sample:
Linolic acid..... 53.3
Oleic acid..... 41.9
Linolic glyceride..... 55.7
Oleic glyceride..... 43.9

The bromine contents of the compounds obtained were determined by boiling samples of known weight (about 0.5 gram) with about 2 grams of pure crystals of silver nitrate and 150 cc. of concentrated nitric acid. The silver bromide formed was filtered through a tared Gooch crucible. To facilitate the drying of the precipitate it was first washed with anhydrous ether, and then dried at between 70 to 80°C.

The first and second crops of tetrabromo derivative gave, on the average, a bromine content of 53.5 per cent and a melting point of from 112 to 114°C. Lewkowitsch (3) reports that the oil consists only of the glycerides of palmitic, stearic, and oleic acids, but experimental data show that besides these, linolic acid is also present, for the bromine content and melting point of the tetrabromo derivative found agree with the theoretical bromine content and melting point of pure linolic tetrabromide, which is 53.33 per cent and 113°C. respectively. This is shown in Table VIII.

TABLE VIII.—*A comparison of the melting point and of the bromine content of the compound prepared from palomaria oil with those of linolic tetrabromide.*

Compounds.	Trials.	Melting point.	Bromine content.
		°C.	*per cent*
Compound	1	112° to 114°	
from	2	112° to 114°	53.5
palomaria	3	112° to 113°	
oil.	4	113° to 114°	
Linolic tetrabromide.		113°	53.33

The presence of linolic acid may also be established by the combined iodine value of the liquid acids which is 151.7, a value lying between that of the theoretical values for oleic acid, 90.07, and for linolic acid, 181.42. Furthermore, the bromine content of the residue obtained after removing most of the linolic tetrabromo derivative was, on the average, 46.0 per cent, a figure which falls between the values for oleic and linolic acids, 36.18 per cent and 53.33 per cent respectively. Therefore, the residue was mostly a mixture of the bromo derivatives of oleic and linolic acids. From the bromine content of the residue and the bromine values of the pure compounds, the proportions of the dibromide and the tetrabromide present were calculated. The results are given in Table IX.

TABLE IX.—*Showing the percentages of the glycerides of oleic and linolic acids in the liquid unsaturated acids (calculated from* TABLE VII).

Glycerides.	Experiment I.	Experiment II.	Experiment III.	Experiment IV.	Mean.
	per cent	*per cent*	*per cent*	*per cent*	*per cent*
Linolic acid.....	56.4	54.7	55.6	55.7	55.6
Oleic acid.....	42.8	43.9	44.3	43.9	43.8
Total.....	99.2	98.6	99.9	99.6	99.4

From the percentages of oleic acid and linolic acid in the unsaturated acids (Table VII) and the percentages of unsaturated fatty acids in the neutral oil (Table V), the percentages of linolic and oleic glycerides in the original sample of oil was calculated. The results are to be found in Table X. The table shows that the neutral oil is composed of 29.7 per cent of oleic acid and 37.7 per cent linolic acid. These figures give 31.3 per cent of olein, and 39.7 per cent of linolin in the neutral oil.

TABLE X.—*Showing the composition of the unsaturated fatty acids from palomaria oil.*

Acids.	Found.	Original.	Glycerides in the original oil.
	per cent	*per cent*	*per cent*
Oleic	41.9	29.7	31.3
Linolic	53.2	37.7	39.7
Total	95.1	67.4	71.0

THE SATURATED ACIDS

The lead soaps insoluble in ether were treated with about 300 cc. of dilute hydrochloric acid (1 : 3). The solution was boiled for some time until all the lead soaps were completely decomposed. The solution was cooled and the solid acids were taken up with 60 cc. ether. The ethereal solution was separated from the acid solution and the lead chloride formed and washed with cool water until free from acid. The washed ethereal solution was then dehydrated with anhydrous sodium sulfate. When the ethereal solution became clear, it was filtered through a dry filter paper into a tared Erlenmeyer flask and the ether removed as completely as possible. The physical and chemical constants of the acids are given in Table XI.

TABLE XI.—*Showing the physical and chemical properties of the solid fatty acids from palomaria oil.*

Characteristics.	Solid fatty acid.
Melting point	50° to 55°C.
Solidifying point	45° to 47°C.
Neutralization value	206.4
Mean molecular weight	283.3
Iodine value	6.7
Saponification value	207.7

The solid acids obtained as described above were esterified by dissolving in absolute redistilled methyl alcohol and dried with anhydrous sodium sulfate, saturating the resulting solution with dry hydrogen chloride and then heating under a reflux condenser for 15 hours.

The reaction product was then treated with water and the ester layer separated. The esters were then dissolved in ether, the solution treated with sodium

carbonate solution (1 :5) and the ether layer separated. The ethereal solution was dehydrated with anhydrous sodium sulfate, filtered, and the ether removed by distillation. The weight of the esters was then ascertained and afterwards they were distilled *in vacuo*.

The molecular weight of methyl palmitate is 270.3 and that of methyl stearate, 298.4. The molecular weights of the fractions obtained by distillation lie between these two values and indicate therefore mixtures of the palmitate and stearate. The molecular weight of the last fraction is greater than that of the palmitic ester, indicating an ester of an acid of greater molecular weight, probably stearic acid. From the iodine number of the oil and the percentage of saturated acids in the neutral oil, the proportion of palmitic and stearic acid was calculated. The saturated acid gave 13.3 per cent of stearic glyceride and 14.5 per cent of palmitic glyceride calculated on the weight of the original oil. Table XII shows the composition of the saturated fatty acids of palomaria oil.

TABLE XII.—*Showing the composition of the saturated fatty acids of palomaria oil.*

Acids.	Found.	Original.	Glycerides in the original oil.
	per cent	*per cent*	*per cent*
Oleic	47.3	12.7	13.3
Linolic	51.6	13.9	14.5
Total	98.9	26.6	27.8

Computation to verify Table XII

$$884 : 846 = \frac{43.8}{99.4} : x$$

$$x = \frac{846 \times .438}{884 \times .994} = \frac{370.548}{878.696} = .4217 \text{ gm. wt. of oleic acid in the total liquid glyceride.}$$

$$.0119 \times \frac{846 \times .438}{884 \times .994} = x \; 198.9 = .9981 \text{ neutralization due to oleic acid in solid impure sample.}$$

$$\text{Let } a = .0119 \times \frac{846 \times .438}{884 \times .994} = .005018 = \text{fraction of oleic acid.}$$

$$.0119 \times \frac{840 \times 55.6}{878 \times .994} \times 200.4 = 1.2807 \text{ neutralization of linolic in sample (impure).}$$

$$\text{Let } b = .0119 \times \frac{840 \times .556}{878 \times .994} = .00639 \text{ fraction of linolic acid.}$$

Let x = fraction of palmitic in solid acid sample (impure).
$1-(a+b+x)$ = fraction of stearic in solid acid (impure).
$x \times 219.1 = 219.1\,x$ neutralization of palmitic acid.
$1-(a+b+x)$ 197.5 = neutralization of stearic acid.
$(1-.01147-x)$ $197.5 = (.98853-x)$ 197.5
$= 195.235 - 197.5\,x$ = neutralization of stearic acid.

Therefore the sum of:

$$.9981 + 1.2807 + 219.1x + 195.23 - 197.5x = 207.71$$
$$219.1x - 197.5x = 207.71 - 197.5088$$
$$21.6x = 10.2012$$
$$x = .4722 \text{ palmitic acid.}$$

Therefore:
(.9885—.4722) = .5163 stearic acid.

The percentages raised to the basis of 100, we have:

$$\frac{.4722}{.9885} \times 100 = 47.76 \text{ palmitic acid.}$$

$$\frac{.5163}{.9885} \times 100 = 52.24 \text{ stearic acid.}$$

Calculated to the original sample of oil, we get:
47.76 x 26.6 = 12.704 palmitic acid.
52.24 x 26.6 = 13.896 stearic acid.

When converted to the glyceride, the following percentages of palmitic and stearic acids were obtained:

$$256 \times 3 : 806 = 12.704 : x$$
$$768x = 10239.424$$
$$x = 13.33 \text{ palmitin}$$

$$284 \times 3 : 890 = 13.896 : x$$
$$852x = 12367.400$$
$$x = 14.52 \text{ stearin.}$$

Table XIII gives the complete composition of palomaria oil.

TABLE XIII.—*Showing the composition of palomaria oil.* (*Summary of* TABLES X *and* XII).

Constituents.	Per cent.
Glycerides of:	
Oleic acid	31.3
Linolic acid	39.7
Palmitic acid	13.3
Stearic acid	14.5
Unsaponifiable matter	0.3
Total	99.1

CONCLUSIONS

1. Palomaria seed is composed of 50.2 per cent kernel and 46.8 per cent shell.

2. The kernels contain 72.3 per cent of extractable resin-oil, 68.2 per cent of which is yellowish oil and 31.85 per cent dark greenish resin. The latter can be extracted with 70 per cent alcohol or with sodium carbonate and sodium chloride solution.

3. The kernel was found to have the following composition:

	per cent
Moisture	39.2
Ash	1.7
Ether extract (oil plus resin)	43.9
Protein (N x 6.25)	2.9
Carbohydrates	5.9
Undetermined (by difference)	6.4
Total	100.0

4. The ash has the following composition:

	per cent
Insoluble matter and silica	5.9
Ferric oxide and alumina ($Fe_2O_3+Al_2O_3$)	34.9
Lime (CaO)	37.7
Phosphoric acid anhydride (P_2O_5)	7.2
Potash (K_2O)	2.2
Sulfur trioxide (SO_3)	6.3
Undetermined (by difference)	5.8
Total	100.0

5. The resin obtained from the seed of palomaria is soluble in the following organic solvents:

Ether, chloroform, carbon tetrachloride, alcohol, acetone, acetic anhydride, and the salts of the alkali metals.

6. Palomaria oil is soluble in the following organic solvents:

Ether, chloroform, carbon tetrachloride, acetone, benzone, and alcohol (above 70 per cent).

7. The oil is composed of 70.8 per cent of liquid and 26.5 per cent of solid fatty acids.

8. Palomaria oil apparently has the following composition[3]:

Glycerides of:	*per cent*
Oleic acid	31.5
Linolic acid	39.7
Palmitic acid	13.3
Stearic acid	14.5
Unsaponifiable matter	0.3
Total	99.1

9. Since the glyceride of linolic acid predominates in the neutral oil, it may be considered a semi-drying oil.

ACKNOWLEDGMENT

The writer is deeply indebted to Dr. Francisco A. Quisumbing, Assistant Professor of Chemistry, under whose direction and supervision this work was undertaken, also to Mr. Sofronio Balce of the Department of Chemistry, College of Liberal Arts, whose assistance was of inestimable value; to Dr. A. P. West, Head of the Department of Chemistry, College of Liberal Arts, for his valuable notes on oil analyses, and to Dr. Manuel L. Roxas, Head of the Department of Agricultural Chemistry, for criticisms and corrections made on the manuscript of this paper.

[3] Since the determination of the constants of the oil show a high acetyl value, indicating the presence of some hydroxy acids, these acids may be included in one of the fractions in the process of separation. As no test has been made to identify which hydroxy acid is present it is not possible to indicate in what fraction it is included.

ILLUSTRATIONS

PLATE I.

A branch of a palomaria tree with ripe fruit.

PLATE II.

Fig. 1.

A branch of *Calophyllum inophyllum L.* with open flowers and flower buds. (After West and Brown).

Fig. 2.

A flower of *Calophyllum inophyllum L.*, enlarged.

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PLATE I.

Photograph was taken 12 hours after branch was cut off.
When on the tree the skin of the fruit was smooth.

Fig. 1

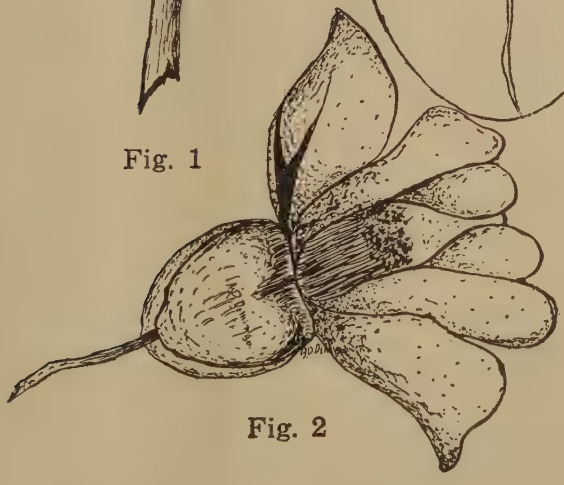

Fig. 2

PLATE II.

DETERMINATION OF THE BEST SEASON FOR HATCHING EGGS IN THE PHILIPPINES[1]

By Nai Thongdee Resananda

INTRODUCTION

The success of a poultryman depends much upon his ability to rear a large percentage of his chicks to maturity. In order to be able to do this, the eggs should be hatched at the right time of the year so that chicks of the desired quality may be produced. In the Philippines this season for hatching is not definitely known; no systematic and elaborate investigation along this line having been conducted heretofore. The problem merits our immediate attention, and its successful solution will, no doubt, be of practical value to the local poultry raisers.

Card (1) working under United States conditions found that April and May are the best months for hatching and that a lower percentage of hatch and consequently more expensive baby chicks prevail in off season hatching.

The study here reported is on the determination of the right season for hatching eggs in the Philippines. It covered a period of twelve months from March, 1923, to February, 1924.

MATERIALS AND METHODS

MATERIALS

In this experiment artificial incubation was used throughout, and one 250-egg Queen incubator was employed. The experiment was conducted in the temporary incubation room of the Department of Animal Husbandry, College of Agriculture. The room is three meters square with a concrete floor and a nipa roof. The walls are made of wire netting. To the height of about two meters from the ground these walls are lined with heavy cotton sheeting to keep out the draft. On rainy and windy days the room does not afford ample protection. However, judging from the excellent incubation results obtained in this work, this room is quite satisfactory, although it is the consensus of opinion that a cellar or an especially constructed room is the best place in which to place an incubator. A hatching room should have even temperature, sufficient moisture content and absence from draft, vibration or direct sunlight (2).

Rhode Island Red, Barred Plymouth Rock, Single Comb White Leghorn, Rhode Island Red-Cantonese Grade, Cantonese, and Native eggs were used promiscuously. Only sound shelled eggs were incubated. Although the eggs were not carefully selected as to size, color, and other characters, those with abnormally thin shells were not used.

The eggs used were laid by hens in the flocks of the Department of Animal Husbandry. These flocks received practically the same feeds and care throughout the year. The birds were weighed individually every four weeks.

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[1] Thesis presented for graduation with the degree of Bachelor of Science in Agriculture, No. 181, Experiment Station contribution, No. 229. Prepared in the Department of Animal Husbandry under the direction of Doctor F. M. Fronda.

METHODS

Incubation.—Incubation was carried on continuously for twelve consecutive months with a hatching at least once in every month. As recommended by Leoncio (3) no eggs more than ten days old were used. Due to seasonal fluctuations in egg production, the number of eggs set varied somewhat in the different months of the year. In order to avoid, as much as possible, the experimental error due to inexperience, artificial hatching trials were made for three successive months before the study was started.

Handling of the eggs.—Each egg was weighed on the same day as laid. A Henry Troemner arm balance, accurate to 500 milligrams, was employed. The eggs were kept, with no special care, in shallow, rectangular, dry and well ventilated open boxes until placed in the incubator. Just before putting them in the incubator each egg was numbered with indelible ink on the small end and then weighed. On the seventh and fourteenth days the eggs were candled, using as a candler, a 300-foot range pocket electric "spot light" placed in a shoe box with an egg-shaped hole at one end. An ordinary lamp tester was sometimes used, or if testing was made during the day, the Buckeye sunlight tester was employed. The infertile eggs found on the first testing were broken into a shallow saucer to determine, as nearly as possible, whether they were really unfertilized or were fertilized eggs in which the germs had died so early they could not be distinguished by candling. On the eighteenth day the eggs were pedigreed by enclosing them in small bags made of mosquito netting, putting one egg in a bag, or two and even three of widely different breeds. When twenty-four hours old the chicks were taken out, weighed and leg-banded. After that they were turned over to the general flock of the department.

Management of incubator.—The cooling and turning of the eggs was done twice a day; once in the morning before attending to the incubator lamp; again, in the afternoon between five and six o'clock. The egg trays were also shifted twice a day just after cooling. Jackson (4) observed that of all eggs set that were turned twice, 66.0 per cent hatched, while but 59.8 per cent of the unturned eggs gave living chicks. Lippincott (5) suggests that "In practice the eggs should be turned as frequently as possible. In most cases this will be three times daily, morning, noon, and night." With regard to the cooling of eggs, authorities differ. Lippincott says that eggs should be cooled as it enhances ventilation, but Lamson and Kirkpatrick (2) report that of the fertile eggs that were cooled 67.0 per cent hatched, and 70 per cent hatched where the eggs were not cooled. Stewart and Atwood (6) observed that chicks hatched from a well ventilated incubator appear stronger at the age of three weeks than when the eggs were not cooled.

Besides a water bath which was placed in the incubator under the egg trays throughout the incubation period, additional moisture was supplied to the eggs in the form of warm water—as warm as the hand of the operator could stand—sprinkled on the eggs on the seventh, fourteenth, and eighteenth days.

The weather records used, giving air temperature, rainfall, relative humidity, and wind velocity were furnished by the Department of Botany, College of Agriculture. The tabulation of these observations follows:

Months.	Average temperature.	Average relative humidity.	Total rainfall.	Average wind velocity.
	°C.	*per cent*	*mm.*	*km.*
March	25.1	81.0	113.3	133.06
April	26.9	78.0	8.0	126.47
May	26.5	82.0	207.8	86.40
June	26.2	85.0	335.5	82.70
July	25.8	86.0	511.1	106.52
August	25.8	84.0	523.9	131.46
September	26.2	83.0	219.0	78.35
October	25.8	84.0	134.5	78.35
November	24.7	80.4	498.9	108.12
December	24.2	80.5	170.2	108.77
January	23.9	86.0	91.1	100.41
February	25.0	85.0	3.9	121.49

EXPERIMENT AND RESULTS

Altogether, sixteen hatches were made in this study, involving the use of 3,093 eggs. From this number, 1,697 (54.86 per cent) baby chicks were produced, 23 (1.36 per cent) of which were abnormal or "cripples;" 135 eggs (4.36 per cent) were infertile; 543 (17.56 per cent) had germs that died in the first week; 179 embryos (5.79 per cent) perished in the second week; 476 chicks (15.39 per cent) were found dead in the shells; and 63 (2.04 per cent) pipped. The incubation results arranged according to months are given in Table I. For convenience in study these results of incubations by months are classified under different columns, namely, infertility, death during the first week, death during the second week, death in shell, pipped, percentage of hatch of all eggs set, percentage hatch of all fertile eggs, percentage hatch of all eggs remaining after the second testing, and percentage of cripples.

It may be mentioned that "infertility" as used in this experiment includes only eggs that have been tested out on the seventh day and which were later found to be really infertile, by breaking. If all the eggs tested out at the end of the first week were to be included, as is sometimes done (3), the percentage of hatch of all fertile eggs would be very much greater than is given. To be able to count, or rather to estimate, the number of chickens before they are hatched, may sometimes be helpful and desirable, for then proper preparation for their reception can be made in advance; hence, the presence of the column, "the percentage of hatch of all eggs remaining after the second test." Collectively, "deaths during first week," "deaths during second week," "deaths in shell," and "pipped," is what is designated as "embryonic mortality." They are separated because, by so doing, the number, percentage, and relative time of death can be studied separately.

The average weight of eggs was found by dividing the total weight by the total number of eggs laid. The same procedure was followed in calculating the weight of the baby chicks. These are given in Table II.

In determining the prices of the baby chicks, also given in Table II, many factors had to be considered. It seems advisable to discuss each one briefly here.

Prices of eggs.—The prices of eggs used in this work were as follows: Rhode Island Red, Barred Plymouth Rock and White Leghorn eggs, ₱0.20 each; Rhode Island-Cantonese grade and Cantonese eggs, ₱0.10 each; Native eggs, ₱0.07 each. Eggs that have been tested out as well as those that failed to hatch have

some food value so are not a total loss. For this reason ₱0.03 was credited to every egg tested out during the first week and ₱0.01 to those that died during the second and third weeks.

Fuel cost.—The cost of kerosene used was placed at ₱0.09 a day. This estimate was based on the retail market price of the oil at ₱2.00 a can of five gallons and the amount of daily consumption. In one hatching the lamp was kept lighted for 22 days. In the sixteen hatches made, the total cost of fuel was ₱31.66, or an average of ₱1.98 a hatch.

Labor wage.—The wage of the College student laborer ranges from ₱0.10 to ₱0.20 an hour. The operator in this study was credited at ₱0.15 an hour, which is the medium wage, for his work. The time spent in attending to the incubator was, on the average, 45 minutes a day. The labor wage for the year amounted to ₱39.60, or an average of ₱2.475 for each hatch made.

Depreciation.—Depreciation, including the rent and interest, is put at eight per cent of the incubator cost (₱94.00)[2], or ₱7.52 for the year and ₱0.47 a hatch.

Operation cost.—The operation cost, or the cost for hatching each egg was ₱0.0255. This was obtained by dividing the sum of the fuel cost, labor cost, and depreciation cost by the total number of eggs set.

Price of baby chick.—The price of a baby chick was found by the formula:

$$\text{Price of a baby chick} = \frac{(a - eto) + e(nes)}{neh}$$

in which *a* is the price of the eggs set, *eto*, the value of eggs tested out, *e* the operation cost for each egg, *nes*, the number of eggs set, and *neh* is the number of eggs hatched.

With this formula, the eggs giving living chicks shoulder the reponsibility of the operation cost and the loss incurred by the eggs that failed to hatch.

DISCUSSION OF RESULTS

RESULT OF INCUBATION BY MONTHS

Infertility.—The infertility as may be seen in Table I varies from 1.36 to 9.02 per cent. The average is 4.94 per cent. It is noticeable that during the months of January to June, there was a distinctly higher number of infertile eggs than from July to December. This may be due to the fact that during the first period the egg production was comparatively heavy, hence it is very likely that the male would fail to mate all the laying hens regularly. Besides the strain due to heavy egg production may lower the vitality of the birds to such a degree that a temporary condition unfavorable to the union of the spermatozoa and ova is created. During these months the birds lost heavily, a fact which seems to confirm the foregoing supposition. In either of these probabilities an unimpregnated egg would be the result. Lamson and Kirkpatrick (2) report that infertility may be due to poor stamina of the stock, housing, feeding, breeding, range, selection, health, season, and number of females mated to a single male. From March to June the yard was not in good grass. This condition may also affect fertility of the eggs laid. However, as will be seen later, infertility even at its worst, is not a formidable factor against the hatchability.

Death during the first week.—The heaviest embryonic mortality occurred during the first seven days of the incubation period. It ranged from 9.02 to 23.12

[2] Queen Incubator Co., Lincoln, Nebraska, U. S. A. Catalogue, 1922.

per cent, or 16.85 per cent on the average. Higher death rate prevailed during the months of March to September. It was observed when the eggs were broken for verification that in the majority of cases the germs were rather small at the time of death. In all probability they may have been less than 48 hours old. The writer has a rather strong suspicion that many of the germs may have died before the eggs were placed in the hatching machine. Edwards (7) observed that eggs for hatching purposes should be kept at a temperature below 20°-21°C. otherwise the germs will start to develop, only to be killed by outside changes later. Hannas (8) in a trial of holding eggs kept at various temperatures obtained the following results:

Temperature.	Percentage of hatch.
7.2°-10.0°C. (45.0-50.0°F.)	57.00
15.6°-18.3°C. (60.0-65.0°F.)	51.30
23.9°-26.7°C. (75.0-80.0°F.)	33.70

In the Philippines the temperature at times, even in the shade, is rather high; varying from 23.0 to 27.0 degrees Centigrade. Under this condition the chances are that the germs would start to develop during storage and when unfavorable outside changes occur the weak ones would perish. The belief that this is true is further confirmed in that the percentage of death was less in young eggs than in old ones. And, even in eggs of similar age, the mortality was higher during hot months than during the months with milder temperatures.

Death during the second week.—The percentage of death during the second week was comparatively low. It fluctuated from 1.36 to 7.56 per cent, or an average of only 5.20 per cent. Judging by the size of the germs as seen through the candler the majority of the deaths probably occurred in the beginning of the week, rather than during the latter part of the period.

Death in shell.—The embryo chicks that died at the end of the incubation period, that is, in the third week, without pipping the egg shells, come under this heading. Next to the first week mortality, the death in shell was the heaviest. It ranged from 6.77 per cent to 22.11 per cent; 14.87 per cent being the average. Death in the shell seemed to be of similar magnitude as death during the first week. Where there was high death rate in the first week, the number that died in shell was also fairly great. Upon post-mortem examination almost always the embryos were found to have been fully developed when death took place. Whether the evaporation was too rapid during this period is not known, but it remains a fact that the unborn chicks seemed to lack moisture. There was no decomposition, and they looked more like sleeping chicks than dead ones.

Pipped.—This refers to the chicks that died after they had broken the shells and stuck their beaks wholly or part of the way out. The percentage of pipped, on the whole, was practically insignificant, being from 0.00 to 4.43 per cent. The average was only 2.11 per cent. When there was crowding in the incubator more pipped chicks usually occurred. This result was probably because there was not enough room and the chicks instead of struggling out gradually were

forced to remain inside the shell. Also, the incubator temperature may rise above normal and this may affect the chicks adversely.

Percentage of hatch of all eggs set.—The number of living chicks obtained from one hundred eggs set varied greatly. It rose from 38.42 to 72.18 per cent, with 56.53 per cent as the average. This result bears out the estimate made by Dunn (9) that the embryonic mortality in domestic poultry is about 50 per cent and that the hatchability of the artificially incubated eggs is not far from 50 per cent. The percentage of hatch obtained in this work was higher than that of Card (1) who obtained, under United States conditions, 50.34 per cent hatch of all eggs set. His percentage of hatch ranged from 18.2 to 78.4.

As a rule in this work favorable results prevailed from July to February, rising from 59.9 per cent in July to 72.18 per cent in January. From March to June the hatching did not give good results. The number of chicks produced from every one hundred eggs during these months fluctuated between 38.42 to 51.19. On the other hand, in the United States, from April to September there is high hatching percentage varying from 51.7 to 78.4, but from November to March the eggs do not hatch well, the percentage of hatch varying from only 18.2 to 49.4. The differences in the best hatching season in the Philippines and in the United States may be due, to a large extent, to the dissimilarity of climatic conditions and other environmental factors found in the two countries.

Percentage of hatch of all fertile eggs.—When the percentage of hatch was based on the number of fertile eggs set, the result was more encouraging. It varied from 41.14 to 79.34 per cent, or 59.21 per cent on the average. The tendency of hatchability is the same as that of the percentage of hatch of all eggs set.

Percentage of hatch of all eggs remaining after the second test.—If a systematic recording of the percentage of hatch of eggs remaining after the fourteenth day were made, and after the incubation work had been continued for two or three years, a definite figure as to the percentage of hatch of all eggs remaining after the second test could be given. The advantage derived from such information is self-evident. It would be of particular advantage when the operator undertakes the selling of day-old chicks. The percentage of hatch when based upon the number of eggs remaining after the second test was very encouraging. The lowest on record was 62.81 per cent while the best result went up to 91.43 per cent, 76.30 per cent being the average.

The variations in the hatchability of eggs, according to Pearl and Surface (10), are largely determined by the individual fowl that laid them, and fowls vary as much in the hatchability of their eggs as they do in the number of eggs that they lay. Lewis (11) believes that poor hatch is due to one or more of the following causes: poor eggs, faulty condition of the breeding stock, great infertility of the eggs previous to hatching or lack of care, inexperience, faulty management of the machine, and poor thermometers.

There is no doubt that one, or more, of the factors cited above, are responsible for the poor hatches encountered during the progress of this work.

WEIGHT OF THE EGGS AND CHICKS

The weight of eggs set and the weight of chicks are given in Table II.

Weight of eggs.—With every breed, the weight of eggs fluctuated during the different months of the year. The average weight when laid were as follows: Rhode Island Red, 52.90 grams; Barred Plymouth Rock, 48.60 grams; White

Leghorn, 47.37 grams; Grade, 46.30 grams. The size of the eggs is more of a hereditary character than the result of environmental factors (2).

Weight of chick.—As would naturally be expected, large eggs will give large chicks. The same order of weight as that for eggs in the preceding paragraph prevailed: Rhode Island Red chicks came first with 34.6 grams; Barred Plymouth Rock, second, 31.4 grams; White Leghorn and Grade third, 29.5 grams and 30.8 grams, respectively; Cantonese fourth, 29.7 grams and Native last, 26.8 grams. Like the weight of the eggs when set, the weight of the twenty-four hour old bird fluctuated.

Quality of chicks.—Judging from their weight, condition, and general appearance, the quality of the chicks hatched in different seasons is quite similar. The chicks were the same fluffy, active, interesting and lovable creatures in January as they were in any other month of the year. However, it may be stated that when a great number of eggs remained in the incubator after the second test, and after they were put in pedigree bags, crowding always occurred. In such cases a greater number of cripples and pipped, than at other times, appeared. The reason for this is that there was not enough room in the egg tray for the chicks to struggle out of the shells; as a result some died in the shell soon after their successful pipping, and some partially dried up and had to be helped out from their coverings. When there were about 150 eggs in the incubator after the second test, crowding did not take place and few, if any, abnormalities were observed. A greater percentage of cripples appeared in the period from January to May than from July to December. Variations in incubator temperature may also cause abnormalities (2).

COST OF CHICK

The cost of chick is shown also in Table II. The differences in prices of chick during any month are due to two factors: First, the percentage of hatch; and second, the relative number of deaths during the first, second, and third weeks. Even with the same number of eggs set and the same number of chicks hatched, the price of chicks in each case may not be the same. The reason for this is that ₱0.03 is credited to eggs eliminated during the first week and only ₱0.01 is given to those that died later.

The initial investment on a Rhode Island Red chick was from ₱0.2694 to ₱0.8689 or ₱0.5286 on the average. A Barred Plymouth Rock chick was a little cheaper, being ₱0.5128, but the price range was greater, from ₱0.2833 to ₱1.0233. A White Leghorn chick was produced at from ₱0.2784 to ₱0.5230. The average was ₱0.3783. The Cantonese chick was comparatively cheap. The price varied from ₱0.1413 to ₱0.2620 a piece, or an average of ₱0.2027. The Native chick cost ₱0.2233. The reader should be reminded that the great difference in cost of different breeds of chicks is, to a marked degree, due to the difference in prices of eggs rather than to the variations in the number of chicks hatched. The prices of chicks shown in Table II was the actual initial cost incurred in this work. It should not lead any one to the belief that if he were to go into incubation business he would face the same expenditure. The cost of a day old chick can be materially reduced by using the incubator only in the favorable months of the year and setting only well selected and properly cared for eggs. Even in this work, during the good hatches, the prices were not high,

being ₱0.3347, ₱0.2842, ₱0.2784, ₱0.1596 and ₱0.1307 for Rhode Island Red, Barred Plymouth Rock, White Leghorn, Cantonese, and Native chicks, respectively. The price of "Grade chicks" is omitted from the discussion for the reason that only three hatchings were made of their eggs. It should be remarked here that the egg supply is more abundant from January to June than from July to December (12), (13), (14).

RELATION BETWEEN THE CONDITION OF THE HENS AND HATCHABILITY OF THEIR EGGS

Weight of hens.—Regardless of breeds, the condition of the hens showed the same phenomenon. The hens gradually gained in weight from the month of July and reached their maximum weight either in the months of September, (Cantonese); October (Rhode Island Red and Native); November (White Leghorn); December (Barred Plymouth Rock). After the highest mark was attained a gradual and persistent decline began and continued till the minimum was reached in May.[3]

Incident to the increasing egg production the greatest decrease in weight started in January and reached the lowest weight in May. From May the birds gradually began to recuperate and gain in weight. When July came they were in good flesh.

Hatchability of eggs.—A careful examination of Table I reveals the fact that high percentages of hatch were distributed between July and February, the highest being from October to February. From March to May poor hatches prevailed. There seemed to be a tendency for the eggs to improve in hatchability as the hens improved in condition. In other words when the hens were in good condition their eggs seemed to hatch better. In January and February, although the hens lost in weight, very good hatches were obtained. This may be due to the fact that during January and February there was low temperature which may produce the probable mortality during keeping, thereby indirectly increasing the hatching percentage.

RELATION BETWEEN CLIMATIC CONDITION AND HATCHABILITY

The climatic record used in this work is that of monthly average, except the total rainfall.

Temperature.—In the year 1923, low temperatures were registered in the months of November, December, January and February, being 24.7, 24.2, 24.0 and 24.8 degrees Centigrade, respectively. The thermometer readings began to decline in November, gradually going downward and reaching the lowest mark in January. From February on there was a gradual and steady rise of the mercury until April when 26.9 degrees Centigrade, the maximum temperature of the year, was registered. From April to October the thermometer shows high but fluctuating readings, varying from 25.8 to 25.9 degrees Centigrade.

In November, December, January, and February very good percentages of hatches were obtained. In March, April, May, and June only 51.19, 38.42, 45.36 and 46.96 per cent of hatch were obtained. In the former period the temperature was very low while in the latter period high temperature prevailed. Thus, there seemed to be a close relationship between the temperature and hatcha-

[3] The records of the weights of the hens are not reported because of the unwarranted amount of space it would occupy.

bility. The tendency was for the eggs to hatch better in months with low temperature. From March to May, the birds lost weight heavily as a result of heavy production. There is no doubt but that the losing condition of the birds may have influenced the hatchability of the eggs.

Relative humidity.—There was a high percentage of relative humidity throughout the year. The difference in any two consecutive months was insignificant, being less than five per cent at the most. Under this condition the same influence of the water vapor in the air would have affected the eggs in every hatch, consequently, whatever variation there was in the hatchability of the eggs, humidity certainly played a very insignificant rôle.

It should not be forgotten that the changes of weight of the hens, the climatic conditions, and some other environmental factors exerted their influences simultaneously. Therefore, whatever influence was manifested on the hatchability of the eggs, that influence was the result of those forces acting in opposition.

Rainfall.—Rainfall was more abundant and better distributed during the months of July to December than during January to June. Heavy rains occurred from June to November. Only light rains came in the months from January to April. The months of good rainfall were also the months in which eggs hatched better. This may have been due to the fact that rainfall helped to make grass on the range grow, which in turn may have imparted vigor to the fowls through its green succulent leaves. The amount of rainfall did not affect the percentage of relative humidity at the College of Agriculture. During a month of heavy rain, the relative humidity may be equal to, or less than that of a month having less rain. This is because the place is naturally humid. However, rainy months have strong winds and storms which may affect unfavorably the hatching or rearing of the chicks.

Wind velocity.—Relatively speaking, the average daily wind velocity was high from January to April, medium from May to August, and low from September to December. However, the wind velocity did not manifest a close relationship to the hatchability of the eggs, because the same percentage of hatch, such as that obtained in July and August, 59.91 and 58.64 per cent, did not have the same wind velocity. The daily average of wind velocity in July was 106.52 kilometers while in August it was 131.46 kilometers, but the hatches were almost the same. Again, in November and December, the wind blew at the same velocity, yet the hatches were very different. The effect of wind velocity is keenly felt when it comes in hard storms during the rainy months, otherwise the poultryman can overlook its influence.

SUMMARY AND CONCLUSIONS

1. The total infertility observed in these studies was 4.36 per cent with an average of 4.44 per cent each month. Greater infertility occurred from January to May than from June to December.

2. The embryonic mortality under the conditions of this experiment was heavy, totalling 17.56 per cent for the first week, 5.79 per cent during second week, 15.39 per cent death in shell, and 2.04 per cent pipped.

3. Best hatches were obtained in October, November, December, January, and February. The corresponding percentages of hatch were 67.40, 63.56, 70.43, 72.18 and 60.59 on all eggs set and 69.23, 66.45, 73.10, 79.34, and 62.44 on all

fertile eggs set, and 85.00, 84.43, 88.70, 91.43, and 74.56 on all eggs remaining after the second week. However, during these months the egg production was low, consequently there was a scarcity of eggs for hatching.

4. The incubation cost was, on the average, ₱0.0255 an egg.

5. The cost of a day-old chick based on the total eggs used in this work was: Rhode Island ₱0.4900; Barred Plymouth Rock ₱0.4490; White Leghorn ₱0.3629; Cantonese ₱0.1887; Rhode Island-Cantonese grade ₱0.2108 and Native ₱0.1687.

6. There was no apparent difference between the quality of the chicks hatched in various months. The average percentage of cripples was 1.36. More abnormalities appeared from March to July.

7. When the hens were in good condition the tendency was for their eggs to hatch better.

8. At this College there is a very high but uniform percentage of relative humidity. However, it did not appear to have any influence on the hatching quality of eggs.

9. Eggs hatched better in months of low temperature than in months of high temperature.

10. Eggs seemed to hatch better in months of abundant and well distributed rainfall.

11. The wind velocity, ordinarily, did not affect the hatchability of the eggs.

12. Because of differences in breed, age, size, and thickness of shell the hatches were not uniform. It required about 30 hours after the first chick came out of the shell to complete the hatch.

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TABLE I.—*Showing the results of incubation by month.*

	Number of eggs set.	Infertiles.		Deaths during first week.		Deaths during second week.		Deaths in shell.		Pipped.		Hatch.				Cripple.	
		Number.	Per cent.	Number.	Per cent.	Number.	Per cent.	Number.	Per cent.	Number.	Per cent.	Number.	Per cent of all eggs set.	Per cent of all fertile eggs.	Per cent of eggs remaining after 2nd test.	Number.	Per cent.
March	211	16	7.58	36	17.06	11	5.21	37	17.54	3	1.42	108	51.19	55.38	72.97	3	2.77
April	466	26	5.58	102	21.88	53	11.37	103	22.11	3	0.64	179	38.42	41.14	62.81	5	2.79
May	291	16	5.50	67	23.02	22	7.56	50	17.18	4	1.38	132	45.36	48.00	70.97	3	2.27
June	296	10	3.39	63	21.28	19	6.41	52	17.57	13	4.39	139	46.96	48.60	68.13	4	2.88
July	222	6	2.70	34	15.32	6	2.70	36	16.22	7	3.15	133	59.91	61.57	75.57	4	3.00
August	220	3	1.36	41	18.64	3	1.36	42	19.09	2	0.91	129	58.64	59.45	74.56	1	0.78
September	199	9	4.52	46	23.12	13	6.53	37	18.59	7	3.52	87	43.72	45.80	66.41	0	0.00
October	227	6	2.64	30	13.22	11	4.85	21	9.25	6	2.64	153	67.40	69.23	85.00	0	0.00
November	324	14	4.32	51	15.75	15	4.63	32	9.89	6	1.85	206	63.56	66.45	84.43	2	0.50
December	301	11	3.66	38	12.62	13	4.32	24	7.97	3	1.00	212	70.43	73.10	88.70	0	0.00
January	133	12	9.02	12	9.02	4	3.01	9	6.77	0	0.00	96	72.18	79.34	91.43	0	0.00
February	203	6	2.96	23	11.33	9	4.43	33	16.26	9	4.43	123	60.59	62.44	74.56	1	0.88
Total	3093	135	4.36	543	17.56	179	5.79	476	15.39	63	2.04	1697	54.86	57.27	75.89	23	1.36

TABLE II.—*Showing the average weight of eggs set, the average weight of day-old chicks, and the relative cost of each baby chick produced.*

Breeds.	Total number of eggs set.	Average weight of eggs set.	Total number of eggs hatched.	Average weight of day-old chick.	Cost of day-old chick.
		gm.		*gm.*	*centavos*
Cantonese	909	44.6	579	29.7	18.87
Single Comb White Leghorn	254	45.7	153	30.4	36.29
Rhode Island-Cantonese Grade	122	44.3	67	29.5	21.08
Native	1259	40.9	646	26.8	16.87
Barred Plymouth Rock	276	47.1	133	31.4	44.90
Rhode Island Red	273	51.2	119	34.6	49.00

THE EFFECTS OF ETHERIZATION ON GERMINATION OF TROPICAL SEEDS[1]

By Francisco C. Panganiban

INTRODUCTION

In the Philippine Islands, particularly in regions where irrigation water is not available and rainfall often comes very late in season, it is important that some means of hastening germination of seeds be investigated. If the results so obtained be found practicable, it may be possible to produce a more rapid vegetative growth and early production in agricultural plants to meet special demands for certain seasons. This hastened growth would be especially valuable with upland rice and other crops which are not planted until the first rains. If the rain comes late in season, planting is so delayed that the crops are grown out of season and consequently the harvest is delayed.

REVIEW OF LITERATURE

Bonns (1) in 1918 reported that ether has little effect as a stimulus except in low concentration, and gives a résumé of the previous literature on the subject.

Bernard[2] in 1878 noted the inhibiting action of ether on the sprouting seeds. Siragusa[2] in 1879 confirmed the inhibiting action of ether and also pointed out the subsequent recovery of the seeds. Romanes[2] in 1894 reported that no appreciable effect of ether was found on germination of various seeds. Townsend[2] in 1899 reported that weak doses of ether accelerated germination of cereals and vegetable seeds, while stronger ones either retarded or completely inhibited such action.

Dixon[2] in 1902 found that the resistance of seeds to toxic agents, such as chloroform and ether poisons as indicated by germination after treatment, depended on the integrity of the seed coat. Becquerel[2] in 1905 also found that the lack of injury depended largely upon the integrity of the seed coat. Beherens[2] in 1906 regarded the shortening of the resting period of seeds due to the effect of ether vapor as a pure stimulus, independent of seed coat permeability. In 1906 Burgerstein[3] found that 24 hours exposure of seeds of *Phaseolus, Cucurbita, Helianthus, Zea*, etc., to ether vapor resulted in germination stimulus, while seeds which had previously imbibed water suffered a retardation. Keesling[3] in 1911 reported that the germination of barley was stimulated by subjection to ether vapor for 80 minutes, while a longer treatment resulted in reduction in rapidity and percentage of germination. Hempel[3] in 1911 reported that ether retarded the germination of *Pisum* seedlings.

Sigmund (2) reported that anaesthetics and CO_2 in gaseous forms were very injurious while in liquid form they retarded germination.

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1 Thesis presented for graduation with the degree of Bachelor of Agriculture, from the College of Agriculture, No. 182; Experiment Station contribution No. 230. Prepared in the Department of Plant Physiology under the direction of Professor D. A. Herbert.

2 *Cited by* Bonns (1).

3 *Cited by* Bonns (1).

Hempel (4) claimed that ether narcotization produced by small doses for protracted periods or by large doses for short duration was characterized by retardation of normal processes of plant activity. She further claimed that the other toxic phase on exposure of long duration produced all the phenomena characteristic of the death of plants.

Johansen[4] reported that in northern Europe the practice of etherization was very successfully employed in forcing lilac for cut flower trade, while in southern Europe it was usually applied to "mimosa", a species of Acacia.

Bonns(1) regarded the effect of ether on germinating seeds as anaesthetic.

Osterhout (5) in his work with anaesthetics found that ether and chloroform had two distinct effects on permeability. One showed toxic effect as evidenced by an increase in permeability, while the other involved a decrease in permeability. From this result he made the conclusion that the reversible change involving a decrease of permeability is associated with the anaesthetic action. His work further claimed that typical anaesthetics decrease the permeability of the tissue to ions, which is considered insignificant in view of the fact that the transmission of the nervous and the other stimulus is believed to depend on the movement of ions within the tissue.

OBJECT OF PRESENT WORK

To find out the effect of etherization on germination of tropical seeds under Philippine conditions, it is necessary that work to that effect be carried out.

The objects of the present work may be classed under two heads:

1. To determine the immediate effect of etherization on germination of tropical seeds, and to find out the length of time seeds may be subjected to ether vapor to produce the earliest germination.

2. To find out whether the effect of etherization not shown on germination will be exhibited at the time of flowering.

This work was carried on in the College of Agriculture, University of the Philippines, Los Baños, beginning November 1922, and ending August 1923.

MATERIALS AND METHOD

The plants or seeds used in this work were the following:

Oryza sativa, rice; *Zea Mays*, maize; *Luffa acutangula*, patola; *Lycopersicum esculentum*, tomato; *Arachis hypogaea*, peanut; *Vigna sinensis*, cowpea; *Phaseolus lunatus*, patani; *Ipomœa batatas*, sweet potato; *Allium sativum*, garlic.

Four hundred seeds each of the rice, corn, cowpea, patola, patani, tomato, and peanut were selected. Eighty bulbs of garlic and eighty sweet potato tubers were also secured. Each kind of the seeds, bulbs, and tubers, were divided into four lots each; the rice, corn, cowpea, patola, patani, tomato and peanut had 100 seeds to a lot, while garlic and sweet potato had 20 bulbs and tubers, respectively to a lot.

Nine dessicators were used as etherization chambers and only C. P. ether was used in the treatment. The amount of ether used was 40 grams per 100 liters of space and during the treatment the dessicator openings were sealed with vaseline so that the atmosphere of ether vapor could not escape.

The first lot of seeds of the first three kinds were exposed for 72 hours in atmosphere of ether vapor; the second lot for 48 hours and the third for 24 hours.

[4] *Cited by* Duggar (3).

The treatments were so arranged that they closed at the same time on the same day. Immediately after treatments, the etherized seeds, with the fourth lot, as control, were placed separately between moist blotting papers to germinate. The blotting papers were moistened as often as necessary and the germinating seeds were observed at intervals of 12 hours, noting the period and percentage of germination. The same treatment and procedure were used with the other seeds, bulbs, and tubers.

One of the etherized lots of seeds in which no effect on germination was observed, that is, which suffered no injury stimulus, was planted with the control separately in plots. During the period of growth, the same treatment was given to both lots. The dates of flowering of the plants raised were observed. (The plant used in this work was maize.)

RESULTS

The results are presented in tables as follows:

Table I shows the length of time required for germination for both etherized and unetherized seeds and the percentage of germination.

Table II shows the length of time required before the plants from both etherized and unetherized seeds produced flowers.

TABLE I.—*Length of time in days to germinate of both etherized and unetherized seeds and per cent of germination.*

Name of plant.	Length of treatment.	Germination period.	Per cent germination.
	hours	*days*	
Rice	control	2	88
Rice	24	4	77
Rice	48	5	90
Rice	72	none	germinated
Sweet potato	control	2.5	100
Sweet potato	24	3	100
Sweet potato	48	5	95
Sweet potato	72	7.5	50
Garlic	control	1.5	100
Garlic	24	3	70
Garlic	48	3.5	45
Garlic	72	none	germinated
Tomato	control	3	17
Tomato	24	4	12
Tomato	48	4	12
Tomato	72	4	13
Cowpea	control	1.5	87
Cowpea	24	1.5	75
Cowpea	48	1.5	77
Cowpea	72	1.5	83
Patola	control	2	12
Patola	24	2	23
Patola	48	2	16
Patola	72	2	14
Patani	control	2	54
Patani	24	2	21
Patani	48	2	68
Patani	72	2	66
Peanut	control	2	100
Peanut	24	2	100
Peanut	48	2	100
Peanut	72	2	100
Maize	control	3	96
Maize	24	3	90
Maize	48	3	94
Maize	72	3	94

TABLE II.—*Length of time in days before flowers are produced by plant from both etherized and unetherized seeds.*

Trials.	Treatment.	Length of time to germinate.	Date of planting.	Date of flowering.	Length of time required before flowers appeared.
		days			*days*
First trial	control	3	8/XI/22	25/XII/23	47
	etherized	3	8/XI/22	25/XII/23	47
Second trial	control	3	7/VII/23	24/VIII/23	48
	etherized	3	7/VII/23	24/VIII/23	48

DISCUSSION OF RESULTS

The results of this work may be classed under two heads, namely:

1. Those in which ether vapor acted as an inhibitory agent.
2. Those in which ether vapor did not affect the seeds at all.

In Table I it may be noted that ether vapor inhibited the germination of rice. Under normal conditions the unetherized seeds of rice as shown in the table germinated within two days, whereas seeds exposed to atmosphere of ether vapor for 24 hours required four days before germination took place. Rice seeds etherized for 48 hours required five days before they germinated, while those exposed for 72 hours to ether vapor did not germinate at all. Upon examination of the ungerminated seeds, it was found that they had lost their viability completely, showing that long exposure to ether vapor is detrimental to the life of the young plant in the seeds. The germination of sweet potato, as with rice, was inhibited by ether vapor. The unetherized tubers produced shoots within two and one-half days, giving 100 per cent germination. The tubers exposed to ether vapor for 24 hours required three days to germinate, a slightly longer period than with the unetherized tubers. Those etherized for 48 hours required five days before germination took place, here the percentage of germination was lowered to 95. Those etherized for 72 hours required seven and one-half days to germinate, a very much longer time than required by the control, and the percentage of germination was lowered to 50. Upon examination, it was found that the tubers which failed to germinate were rotting; a result which may be attributed to chemical changes that took place in the tubers due to the action of ether.

Garlic, like rice, upon long exposure to ether vapor failed to germinate. This failure of the bulbs to germinate was found in those exposed to ether vapor for 72 hours. The unetherized bulbs of garlic germinated within one and one-half days, while those etherized for 24 hours required three days to germinate; here also, the percentage of germination was lowered. The bulbs etherized for 48 hours required a slightly longer period to germinate, and gave only 45 per cent of germination, a very marked lowering.

Tomato was slightly affected by ether. The unetherized seeds germinated within three days while those etherized, regardless of the length of exposure germinated within four days.

These results show that ether had an inhibitory action on the germination of some seeds exposed for a period of 48 hours or less; while if exposed for 72 hours

or more, it gave a purely poisonous effect, resulting in the death of the young plant. These results corroborate the report of Townsend[5] who found that while weak doses of ether accelerated germination of cereals and vegetable seeds, stronger ones, either retarded or completely inhibited such action. The work reported in this paper corroborates the report of Hempel (4) who claimed that ether-narcotization produced by ether vapor is characterized by retardation of normal processes of plant activity.

Upon examination of Table I it may be found that ether vapor does not affect the germination of cowpea, patola, patani, peanut, or corn. This resistance to injury may be attributed to the integrity of the seed coats as claimed by Dixon[5] and Becquerel[5].

In order to find out whether seeds which did not show any effect of ether vapor on germination suffered any injury from ether, an unetherized lot and an etherized lot of corn seeds were planted in plots and raised to flowering. On observation it was found that plants from both the etherized and unetherized seeds flowered at the same time. This fully corroborated the results which had been found in this experiment that certain seeds are resistant to the action of ether vapor.

The injurious effects of ether may be produced in two ways:

1. Destruction of the oxidizing enzymes in the seed.
2. Attack on the fatty constituents of the protoplasmic membrane.

The first way was demonstrated by the work of Haas (6) who studied the respiration of *Laminaria* (a seaweed) treated with ether. He found that in excess, ether produced a marked falling off in the respiration. The results obtained by Haas are a confirmation of the earlier work of Irving (7), Thoday (8) and others. Appleman (9) has shown that the relation of catalase, one of the oxidizing enzymes to respiration, is in direct proportion, while there is little correlation between the amount of respiration and other oxidizing enzymes. Ether is injurious to catalase, hence it is extremely likely that part, at least, of the injurious effects of etherization can be traced directly to this action. This conclusion is supported by the fact that small amounts of ether cause not a depression in respiration but an acceleration. The use of ether as a stimulant rests, then, on the possibility of using an amount sufficient to cause an acceleration of oxidatory activity yet not enough to cause an injury.

The results here presented go to show that the concentrations of ether used in the temperate zones either have little effect on the tropical material dealt with or else give an inhibiting effect. Further work with more dilute concentrations of ether will show whether the accelerating influence of small quantities of ether will be enough to produce sufficiently marked results for commercial purposes.

SUMMARY OF CONCLUSIONS

1. Seeds of rice, sweet potato, garlic and tomato on exposure to ether vapor for 48 hours or more suffered injury as exhibited by late germination.

2. Seeds of certain plants, such as rice and garlic, exposed to ether vapor for 72 hours or more, completely lost their viability.

3. Seeds of certain plants as cowpea, patola, patani, peanut and corn were resistant to ether injury owing to the integrity of the seed coat.

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[5] *Cited by* Bonns (1).

4. Etherization in general retarded the germination of some tropical seeds investigated while it did not in any way affect the others, when the reagent was used in the concentrations employed in temperate countries.

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DOUBLED-YOLKED EGGS[1]

By F. M. Fronda

Of the Department of Animal Husbandry

WITH ONE PLATE

As much has already been written on the production of abnormal-sized eggs, such as dwarf eggs (abnormally small eggs) (1), double-yolked eggs (2) (3) (4), and double eggs (5), (6), it would appear that additional reports on the subject would be unnecessary. The present paper, however, should be of interest to biologists, and poultrymen as well, as it gives additional data in support of some of the theories advanced as to the formation of double-yolked eggs, commonly observed produced by domestic chickens and ducks and possibly some other species of domestic fowls.

A grade Cantonese-Native hen was noticed to be laying extremely large sized eggs. On examination, several of these eggs were found to contain double yolks. One of these double-yolked eggs, weighing seventy grams, with perfectly sound shell, was placed in an incubator and observed. Both eggs were found to be fertile in the first testing on the seventh day, and both yolks passed the second testing as living chicks on the fourteenth day. Both of them, however, failed to hatch, and when the egg was opened on the twenty-second day of incubation, two fully developed young chicks were disclosed. (Plate I) The chicks, apparently, developed normally until, probably, the seventeenth day, when they died. The yolk sacks were not yet absorbed into the abdominal cavities, although these were most probably on the point of being absorbed when death took place. On a closer examination, it was revealed that the chicks were two entirely separate individuals enclosed in a common egg membrane and shell. They were connected at no point at all, or in other words, there were two perfectly developed seventeen-day (?) old chicks inside the same egg membrane and shell.

Curtis (4), in classifying double-yolked eggs, mentions three classes, based on the number of common egg envelopes, as follows; (a) Type I—Double-yolked eggs having the entire set of egg envelopes common to the two yolks; (b) Type II—Double-yolked eggs having all or part of the thick albumen common to two yolks, but with separate chalazal membranes; and (c) Type III—Double-yolked eggs in which the yolks have entirely separate thick albumen envelopes but a common egg membrane and shell. Of the 131 cases of double-yolked eggs studied at the Biological Laboratory of the Maine Agricultural Experiment Station by this observer, 16.03 per cent were found to belong to Type I, 70.99 per cent to Type II, and only 12.98 per cent belonged to Type III. The egg here reported clearly belongs to Type III, for there were almost two complete eggs enclosed in a common membrane and shell, as no development of the chicks would have been possible if otherwise. It appears from the observations made by Curtis that double-yolked eggs belonging to this type (Type III) are comparatively rare.

[1] Experiment Station contribution No. 231.

Double-yolked eggs may be formed, as has been advanced by Parker (5) by a simultaneous discharge into the egg tube of two yolks from the same or separate follicles. Glaser (3) suggests that this does not have to happen, since the first yolk may remain in the funnel of the oviduct until the next normal discharge of a second yolk. Curtis (2) further suggests that there are, at least, the following possibilities which may bring about the formation of a double-yolked egg.

(a) The first yolk may be delayed at any level of the oviduct anterior to the isthmus ring, the point where the egg membrane begins to be secreted.

(b) The first yolk may be returned up the oviduct by antiperistalsis and then come back in company with a second yolk.

(c) A yolk may be ovulated into the body cavity and picked up later by the funnel before or shortly after the ovulation of another yolk.

From the evidence obtained by Curtis (4) in his studies on the relation of simultaneous ovulation to the production of double-yolked eggs, he concluded that the production of a double-yolked egg can be seldom explained as a result of simultaneous ovulations. This double-yolked egg in question was apparently formed according to one of the suggestions given by Curtis (2). The first yolk may have been arrested just after the formation of a complete layer of thick albumen over the yolk, that is, before the isthmus, then the second yolk followed normally, and the two yolks together were passed out as a single normal egg. Thus, practically two complete or almost complete eggs were enclosed in a common egg membrane and shell. The fact that, in the case here reported, both of these "eggs" each of which happened to be fertile, were capable of normal development to almost hatching time when further growth was stopped due to some unfavorable conditions, is another proof for this. It is very doubtful if double-yolked eggs, Type II, and more doubtful in Type I, would develop normally, for there would not be enough of the egg materials for the two chicks to utilize in their development.

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PLATE I.

Two fully developed "twin" Chicks from a double-yolked egg. Part of the shell (S) is shown.

ABSTRACT[1]

A study of the effects of ground corn, rice bran, copra meal, and cowpeas as supplements of the basal ration consisting of equal parts of shelled corn and palay for laying hens, AGAPITO E. BUENAVENTURA. (*Thesis presented for graduation from the College of Agriculture, No. 183; Experiment Station contribution No. 232*). In this study, two lots (A and B) consisting in each case of one Cantonese cock and ten Native hens were used. These fowls were obtained from the College flock with one year egg production and were of about the same age. Each lot received an equal amount by weight of whole grains of rice and corn. For supplements, one part ground corn, two parts rice bran, and two parts cowpeas were given to Lot A, and to Lot B was given one part ground corn, two parts rice bran, and two parts copra meal. The observation lasted for seven months—from July 7, 1921, to February 7, 1922.

The results of the experiment show that:—

1. Hens fed with corn, rice bran, and cowpeas produced more eggs during their laying period than hens fed with corn, rice bran, and copra meal.
2. Cowpeas proved to be more palatable to laying hens than the copra meal.
3. The value of egg production in Lot A showed a gain of ₱9.18 over the cost of feeds, and in Lot B, there was a loss of ₱2.19, or Lot A gave ₱11.77 better returns than Lot B.
4. Both lots consumed practically the same amount of feeds. Each fowl in Lot A consumed 13.45 kilograms of grains, 5.12 kilograms cowpeas, 4.15 kilograms ground corn, and 5.06 kilograms rice bran. In Lot B, each hen consumed 13.45 kilograms of grains, 2.13 kilograms copra meal, 5.49 kilograms ground corn, and 4.98 kilograms of rice bran.
5. The average weight of each egg in Lots A and B did not differ very much. Each egg in Lot A gave an average weight of 39.83 grams and of Lot B an average of 39.11 grams, giving a difference of 0.72 grams for each egg in favor of Lot A.

Abstract by Teofilo F. Novero.

[1] Abstract prepared as part of the required theme work in English 101, College of Agriculture.

EXCHANGE NOTES

The cultivation of the oil-palm in Sumatra, we are told, is increasing, and several new estates are reported to have come into being. The output is small but increasing, and the industry is now well established. The demand for Sumatra palm-oil is said to exceed the output.

—*Tropical Life.*

It seems certain that megass has a greater future before it than just to be burned as the refuse of cane. A couple of months ago attention was drawn to the statement that a celotex factory was to be erected in Queensland at a cost of £250,000 and since then frequent reference has been made in foreign sugar papers to this industry. The one company in Louisiana which controls the business is adding to its plant another set of machinery at a further cost of a quarter million sterling, a fact which removes doubt as to whether the figure originally mentioned for the Queensland factory was correct..... The fact that megass can be profitably turned into building boards, which, for many purposes, are more suitable than the ordinary timber of commerce, seems definitely proved. The American Company, it is asserted, has been highly successful from its very commencement, and is now planning to extend its operations to Hawaii, Cuba and possibly the Philippines. It is claimed for the sugar industry that the new departure will add millions to the incomes of the planters. Louisiana, which roughly makes as much sugar in a year as Queensland, is estimated to be capable of supplying enough megass to make 6,000,000 feet of fibre board per day, and it is intended to get megass over from Cuba. The ultimate aim is to replace 43 billion feet of lumber annually. The difficulty one might expect in handling so bulky an article as megass is overcome by having baling stations at the mills. These cost about £12,000 each. From a statement by one of the vice-presidents of the company, printed in the "Planter", I take the following:—

> The first million feet of raw material to be landed in Tokio after the earthquake was fibre board, and five days later we were forced to reject an order for 2,000,000 feet additional. Fibre board is being shipped to England, France, Belgium, South Africa, Canada, and Chile. It is being used in Japan for toy-making, furnishes insulation for oil tanks, sheathing for buildings, packing cases for the Smithsonian Institute, for automobile tops to deaden the sound of the engine, in refrigerator cars, under linoleum to deaden sound, and impregnated with oil as a substitute for cork flooring.

The curious feature of the whole business is that it was established by newspaper men of the North, and not by the sugar people themselves. The boon of increased profits has been thrust upon the producers and manufacturers of sugar. Is the American history to repeat itself in Australia?

—The *Australian Sugar Journal.*

The well-being of the producer is vital to the prosperity of the manufacturer and vice versa.—Business is a humanity-serving agency. The manufacturer and producer are partners in usefulness—They cannot work against each other without doing harm to themselves.

—*World Agriculture.*

You do not come representing governments; you come representing peoples. Commerce and industry are the interplay, the relationship, not between governments but between groups of different people.—PRESIDENT COOLIDGE, Address of Welcome, to the World's Dairy Congress.

—*World Agriculture.*

New footwear includes some unusual varieties. In addition to crocodile and lizard, dealers have shoes made of rare python and shark skin. They have secured a very fine python and are making up the skin, which is an attractive and fashionable fawn color. The shark skin shoes are in a good shade of brown, those of the crocodile skin in a warm chocolate shade approaching henna and lizard shoes are mostly gray and white, the markings varying a little.

—The *London Times* from *Zoological Society Bulletin.*

It should be the aim of college training to develop a closer relation between education and life, and between life and service. Instructors have failed if they have not caused their students to realize that they are being educated for service. The students' services will help better social and economic conditions within their communities. They should, however, be compensated for worth while service.

Many students in their college work are thinking of white collar jobs and of shirking work. Labor is very essential to the accomplishment of anything worth while.

—*The Agricultural Student* (Ohio State University.)

That birds are man's most valuable and yet least valued possession is a fact which is apparent to the comparatively few people who study them. Man generally considers himself to be the prevailing power on earth, but in this he makes a very big mistake. The insects are the dominant power, and as many of them are carriers of disease which affect man either directly or through his products, while others destroy his works, it will be realized that they are man's greatest enemy. We have many scientists who are working continually in an endeavour to find some reliable mechanical insect exterminator; but while we wait we are apt to overlook the fact that certain species of birds will do the work thoroughly if we give them the chance by encouraging them.

Birds, because of their insectivorous diet, form the greatest army that nature can muster in her endeavour to keep insects from becoming plagues. At times when the balance of nature is temporarily upset, insect plagues may eventuate, and at such times birds and man become allies in the great fight. Unfortunately, man soon forgets the work the birds have done for him, and he fails to give them the protection necessary for their welfare and for his own.

From the point of view of agriculture, we must realize that it is impossible to carry on for any time without the help of birds. Let producers of every order protect and encourage them. They are their true friends and allies.

—The *Agricultural Gazette* of N. S. W.

COLLEGE AND ALUMNI NOTES

Dr. Charles W. Hamilton, in charge of Presbyterian Mission Work, Laguna Province, and resident pastor, Presbyterian College Church, recently presented to the College Library a set of the International Encyclopedia and a copy of Transactions of the Illinois Horticultural Society, 1913. Both Faculty and Students are grateful to Doctor Hamilton for this generous gift.

Tropical Agriculture. Vol. I, No. 2, was recently received. This new entrant into the field of agricultural journalism is "the official journal of the Imperial College of Tropical Agriculture" located at St. Augustine, Trinidad, West Indies. The journal presents interesting tropical agricultural news material in a well organized arrangement.

An important subject to be discussed at the Pan-Pacific Food Conservation Conference to be held from July 31 to August 14, 1924, at Honolulu is sugar cane improvement. The sugar section of the Conference has the following topics in their tentative agenda: (1) The propagation of seedlings; (2) Breeding for disease resistance, general hardiness, and ability to ratoon; (3) Methods of selecting and testing seedlings; (4) "Bud Selection"—Its rôle in cane improvement; (5) Sugar cane varieties and their identification; (6) Interchange of varieties between countries with due regard to quarantine precautions.

It is gratifying to note that work on these problems has recently been started in the College of Agriculture or, at least, preliminary results from such investigations obtained. Inasmuch as one of the crying needs of sugar farmers of the Philippines is improved cane variety, characteristically immune to prevalent and serious cane disease, it would appear that if a Filipino delegate was sent to this Conference the knowledge he could bring to the Philippine sugar growers would be invaluable.

A letter, dated March 18, 1924, received by Dean Baker from Prof. Fred W. Ashton, formerly of the Department of Chemistry, tells of his present work as Research Associate in the Bureau of Standards, Washington, D.C.

Hilarion Silayan, '17, now a graduate student U. C., writes Doctor Mendiola under date, April 5, that he is majoring in Farm Management. One of his courses, Land Settlement, is under Doctor Mead, who conceived, planned, and managed the Durham Colony in California, one of the most successful land colonies in the United States. Doctor Mead has recently been appointed U. S. Commissioner of Reclamation.

An inclosed clipping from a Berkeley paper gives further news of Mr. Silayan: "Philippine independence will be the topic discussed at the International Forum

luncheon. H. S. Silayan, a graduate student in Rural Economics who received his degree of bachelor of science from the University of the Philippines in 1917, will speak.

"Silayan has had practical experience in the administration of the Philippine Islands in the office of Lieutenant Governor of one of the provinces."

Mr. Silayan writes:

"Last night I sang to a large audience at the Cosmopolitan Club program, 'Philippines Night.'" As one of the minor features of his College life he closes with, "I am 'hashing' and doing all kinds of decent jobs to get along."

Mr. Deogracias Villadolid, B. Agr. '19; M. S. '23; University Fellow for study abroad, sailed in May for United States. Mr. Villadolid will major in zoology. His headquarters will be Leland Stanford, Jr., University, California.

Mr. Alex. Gordon, B. Agr. '23, has been appointed government pensionado to United States from the office of the Governor General. Mr. Gordon will major in irrigation engineering. His headquarters will be University of California, Berkeley.

Mr. Bonifacio Padilla, '22, was married to Miss Virginia García on April 10, 1924. The ceremony was performed in their home town Santa Rosa, Nueva Ecija. Mr. and Mrs. Padilla will live in Batangas where Mr. Padilla is employed under the Bureau of Education.